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(54) Title: BANDWIDTH PROVISION IN A COMMUNICATION SYSTEM
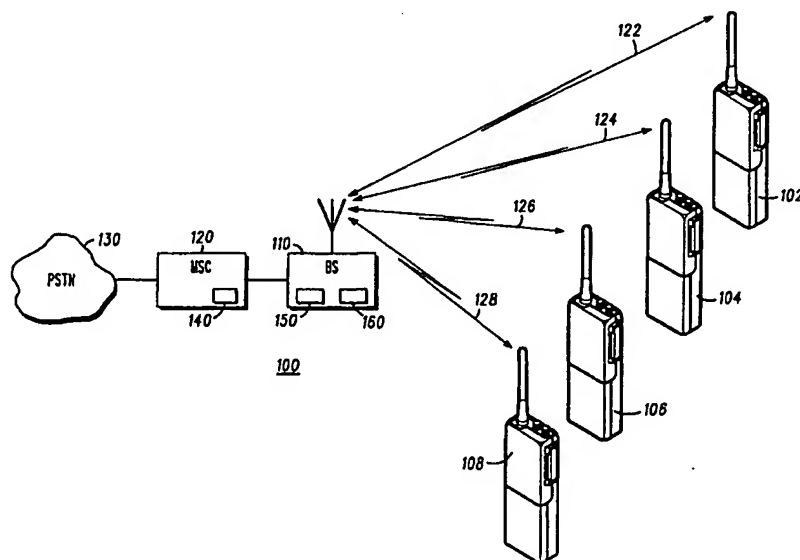
(57) Abstract

A method of operating within a communication system wherein a bandwidth provider responsible for a given bandwidth provides different amounts of bandwidth to respective partial users. The method comprises the steps of determining a bandwidth availability profile; determining a traffic profile; and transmitting capacity information to a partial user, wherein the capacity information comprises the bandwidth availability profile and the traffic profile. Also described is corresponding apparatus for a communication system. The invention is particularly advantageous in network arrangements including cellular radio communication systems, such as UMTS.

BANDWIDTH PROVISION IN A COMMUNICATION SYSTEM

Field of the Invention

5   The present invention relates to a method of operating within a communication
system wherein a bandwidth provider responsible for a given bandwidth of said
communication system provides different amounts of said given bandwidth to
respective partial users of said given bandwidth. The present invention also
relates to an apparatus for such a communication system. The invention is

10   applicable to but not limited to a cellular radio communication system such as
the Universal Mobile Telecommunication System (UMTS) currently under
standardisation.

Background of the Invention

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Communication systems comprise a finite amount of bandwidth resource based
upon the technical means forming the communications links and interfaces
between different parts of the communication system. Also, a bandwidth
resource can be limited for commercial rather than technical reasons. In the

20   present application bandwidth is to be understood in the sense of bandwidth
capacity with respect to communications signalling and traffic. Accordingly,
bandwidth can include or be expressed as number of channels.

In communications systems, there is a hierarchy with respect to provision of the

25   bandwidth resource. The simplest example would be a system, for example a
private landline telephone system, in which a single operator controlled all the .
components including communication links of the communications system. In
this system, the operator represents the sole bandwidth provider. He provides
bandwidth to each subscriber making a telephone call, thus such subscribers

30   represent partial users of the total bandwidth of the system. In this case the
amount of bandwidth provided for each partial user is the same.

A more complicated bandwidth provision hierarchy is one in which total system bandwidth is divided commercially between a first level of partial users thereof represented by different operators who in turn supply respective parts of their bandwidth down a bandwidth hierarchy chain to a second layer of partial users

5   thereof, and so on, until ultimately reaching the final layer of partial users represented by the end-users or subscribers. Both conventional landline telephone systems, and cellular radio communication systems currently exist which are arranged in this manner for commercial reasons. Also, such sub-division of bandwidth takes place in other communication networks connected

10   on a nodal fashion and containing sub-links, such as the internet.

Harmonised interface standards facilitate commercial sub-division of fundamental bandwidth resource within a given communication system. An established harmonised system applicable to cellular radio communication

15   systems is Global System for Mobile Communications (GSM). Statistical multiplexing is employed in GSM systems to enhance spectrum efficiency. Due to the statistical nature of traffic low efficiency can arise, for example a single GSM carrier of seven time division multiple access (TDMA) channels is typically only 42% efficient (2.94 Erlangs at 2% blocking).

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The Universal Mobile Telecommunication System (UMTS) currently under standardisation is intended to provide a harmonised standard under which cellular radio communication systems will provide communications links suitable for transmitting a wide variety of data services. Higher bandwidth needs such as

25   those required by multimedia applications will be encompassed. It is expected that within the framework of developments such as UMTS or the like, cellular radio communication systems will play an increasing role in information communication arrangements including those such as the internet.

30   Generally speaking, the application of bandwidth provision hierarchies within communication systems such as cellular radio communications systems along

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the lines of UMTS creates a broad range of new engineering problems and challenges. Indeed, one of the challenges faced is to envisage what new opportunities arise to provide bandwidth providers and partial users of bandwidth with additional facilities in the light of such application.

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Summary of the Invention

In the light of the above the present inventors have envisaged that systems
10   such as UMTS can be arranged to provide bandwidth from a bandwidth provider to partial users thereof in a variable bandwidth and bandwidth-on-demand mode. The present inventors have envisaged that in systems such as UMTS, such modes will particularly require that the amount of bandwidth provided to a partial user for a particular item of traffic can advantageously be chosen by
15   either the provider or partial user such that spectral efficiency and network capacity are met in a balanced fashion. If the amount of bandwidth provided is insufficient the needs for that traffic will not be met. On the other hand, if surplus bandwidth is needlessly provided then this will waste bandwidth resource hence ultimately rendering the system inefficient.

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The present inventors have envisaged that contrary to conventional systems in which the amount of bandwidth provided for each partial user is the same, in systems such as UMTS different partial users and also different services required by a particular partial users will economically require a different amount
25   of bandwidth.

Furthermore, the present inventors have envisaged that different partial users, and also different services, also have different requirements with respect to quality, e.g. inverse of error rate, and delay, i.e. latency, where delay is the
30   period of time that elapses before the or while a service is transmitted. For example, two way speech telephony has a modest requirement for quality but a

strong requirement for good performance with respect to delay, good performance being a short delay. Text messages benefit trunking and spectrum efficiency by being sent at high bandwidth, although a long delay is acceptable.

5   The present invention advantageously implements means for the bandwidth provider and partial user to take advantage of the characteristics described above and envisaged by the present inventors. More particularly, the present invention will allow for greater utilisation of available capacity, by for example allowing high latency data to be sent in gaps in speech traffic, in an improved

10   fashion based upon new technical possibilities derived by the present inventors with respect to systems such as UMTS.

According to one aspect of the present invention, there is provided a method of operating within a communication system wherein a bandwidth provider responsible for a given bandwidth of said communication system provides

15   different amounts of said given bandwidth to respective partial users of said given bandwidth, as claimed in claim 1.

According to another aspect of the invention, there is provided an apparatus

20   for a communication system wherein a bandwidth provider responsible for a given bandwidth of said communication system provides different amounts of said given bandwidth to respective partial users of said given bandwidth, as claimed in claim 6.

25   Further aspects of the invention are as claimed in the dependent claims.

The present invention provides the partial user with capacity information, which enables the partial user to advantageously make an informed and efficient use of bandwidth facility. Additional specific advantages are apparent from the

30   following description and figures.

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Brief Description of the Drawings

FIG. 1 is an illustration of a communication system in accordance with the present invention.

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Description of a Preferred Embodiment of the Invention

One particular embodiment of the invention is now described by way of example only. FIG. 1 shows a radio communication system 100 including user stations

10   102, 104 and 106, and radio base station (BS) 110. In this example each user station 102, 104 and 106 is a mobile station, more particularly a mobile telephone with display screen. Communication links consisting of radio links 122, 124 and 126 are established between BS 110 and user stations 102, 104 and 106 respectively. The geographical area served by BS 110 constitutes one

15   cell of a cellular radio communication system.

In the present example the operator of communication system 100 has the role of bandwidth provider and is responsible for a given bandwidth of said communication system, which in this example consists of the whole bandwidth

20   provided by BS 110 via its radio links. The respective users of user stations 102, 104 and 106 constitute respective partial users of the given bandwidth from BS 110 for which the system operator is responsible. In the present invention the operator of communication system 100 provides different amounts of said given bandwidth to respective partial users of said given bandwidth, that is different

25   amounts of bandwidth will be employed in the different respective communications from user stations 102, 104 and 106.

In the present example, BS 110 is connected to a mobile services switching centre (MSC) 120, which in turn is connected to a public switched telephone

30   network (PSTN) 130. PSTN can be connected to any other information or communication network, for example the internet. Users or service providers

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can be connected to the communication system through PSTN 130 or
alternatively through an interface coupled directly to MSC 120 or BS 110.

Furthermore it is to be appreciated that the present invention is applicable to
5   other varieties of communication system or network configurations and network
components, arranged in different hierarchical, access and interconnection
formats, in data handling communications systems such as UMTS. Similarly, it
is to be appreciated that according to the specific network configuration and
hierarchies, alternative system components will be incorporated serving different
10   roles compared to BS 110, MSC 120 and PSTN 130. For example, networks
such as UMTS ones may incorporate a public data network as opposed to a
PSTN, and may incorporate a mobile packet switch as opposed to an MSC.
Indeed the invention is applicable to any communication network, including
overall networks consisting of sub-networks arranged in parallel and/or
15   superimposed hierarchical logical format, in which a bandwidth provider is
providing bandwidth down a supply chain to partial users thereof who will
require different respective amounts of bandwidth.

The method of the present embodiment includes the step of determining a
20   bandwidth availability profile with respect to said given bandwidth. The available
bandwidth at a particular time is the difference between the total given
bandwidth that can be borne, in this case by BS 110, and the bandwidth already
in use at that time. An alternative terminology for available bandwidth is
instantaneous bandwidth. In a simplistic version of the present example,
25   consider that only user stations 102 at that particular time is engaged in traffic
communication, thus the bandwidth in use at that particular time is that used in
by user station 102. Hence the available bandwidth at that particular time is
determined accordingly as the difference between the above two described
amounts. This value embodies the simplest form of bandwidth availability profile
30   with respect to the given bandwidth. However, a more preferred form of the
bandwidth availability profile is one which also includes data related to the

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amount of bandwidth that has already been committed to certain partial users. In this example consider that user station 104 has requested a communication channel and that the system operator has committed certain bandwidth to establishing that channel. Then in this case the bandwidth availability profile is

5   determined in the form of a time dependent function including both the exiting usage of user station 102 and the impending usage of user station 104. It will be appreciated that in applying the present invention the skilled person will select the form of the bandwidth availability profile according to the commercial and technical requirements of the particular system under consideration.

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In the present embodiment the means, for determining a bandwidth availability profile with respect to said given bandwidth as described above, is shown as item 140 in FIG. 1, and consists of a discrete processing unit containing electronic circuitry, being located in MSC 120. However, it is to be appreciated

15   that in other embodiments of the present invention such means can be incorporated in the form of software, alternative hardware, manual input means, or a combination of any of the above. Also, the unit embodying such means can be located in other parts of the communication system such as at BS 110, or can even be formed of different component parts distributed in a plurality of

20   locations within the system.

The method of the present embodiment includes the step of determining a traffic profile with respect to traffic waiting to use said given bandwidth. In the present example the traffic waiting to use the given bandwidth is the traffic user station

25   106 wishes to communicate. For clarity, the distinction is drawn between the traffic waiting to use the given bandwidth which is exemplified by that of user station 106, which is characterised in that the system operator has not committed to allocate bandwidth to this traffic, and the traffic of user station 104 which as described above, although not yet sent, is nevertheless included in the

30   determination of the bandwidth availability profile as it is characterised by being traffic that the system has committed to be borne.

In the present embodiment the traffic profile is a function of a level of said traffic waiting to use said given bandwidth. In the present simple case the traffic profile is thus represented by data corresponding to the traffic level to be
5   communicated by user station 106. It is to be appreciated that in other more complicated embodiments the data will correspond to many user stations, and will be processed using appropriate processing techniques.

In the present embodiment the means, for determining a traffic profile with
10   respect to said given bandwidth as described above, are shown as item 150 in FIG. 1, and consist of a discrete processing unit containing electronic circuitry, being located in BS 110. However, it is to be appreciated that in other embodiments of the present invention such means can be incorporated in the form of software, alternative hardware, manual input means, or a combination
·15 of any of the above. Also, the unit embodying such means can be located in other parts of the communication system such as at MSC 120, or can even be formed of different component parts distributed in a plurality of locations within the system.

20   In an alternative embodiment, the traffic profile is a function of a priority of said traffic waiting to use said given bandwidth. Priority refers to the delay criticality of traffic waiting to use the system, for example it can be the inverse of allowable latency. Relating to the present example, the traffic profile is determined according to a profile that lends a higher priority weighting to the
25   traffic of user station 106 if that traffic is to consist of speech, and a lower weighting if the traffic of user station 106 is to consist of text data.

In a further alternative embodiment, the traffic profile is a function of a level of said traffic waiting to use said given bandwidth and is a function of a priority of
30   said traffic waiting to use said given bandwidth. Thus the options described above are combined in one. the specific programmes or algorithms providing

such a combined determination will again be chosen by the skilled person according to the requirements of the particular system under consideration.

In those embodiments described above wherein the traffic profile is a function,
5   either solely or partly, of a priority of the waiting traffic, a further option is that the function of a priority of said traffic waiting to use said given bandwidth is calculated in a non-linear fashion with respect to time for respective components of said traffic waiting to use said given bandwidth. One example is that a long text message may originally be of low criticality with respect to delay in that it
10   can be sent any time within,, say, a four hour period, but on the other hand once transmission has been started it is of high criticality that the transmission is completed within a further time period of, say, five minutes. Alternatively, irrespective of the finite delays permitted, non-linear priority with respect to time can be programmed into the function of priority such as to ensure that high
15   priority is allocated to messages when most of their content is sent, so as to avoid wasteful repetition of the whole message in the event that just the last small part thereof was not sent due to being low priority.

The method of each of the above embodiments also includes the step of
20   transmitting capacity information to a said partial user, wherein said capacity information comprises said bandwidth availability profile and said traffic profile. One possibility is for both the bandwidth availability profile and the traffic profile to be combined before transmission to a partial user. In the present example the capacity information is transmitted to the partial associated with user station
25   108. The means, for transmitting capacity information to a said partial user, wherein said capacity information comprises said bandwidth availability profile and said traffic profile as described above, are shown as item 160 in FIG. 1, and consist of a discrete processing unit containing electronic circuitry and associated radio transmission equipment, being located in BS 110. However, it
30   is to be appreciated that in other embodiments of the present invention such means can include software, alternative hardware, manual input means, or a

combination of any of the above. Also, the unit embodying such means can include component parts distributed in a plurality of locations within the system.

5   In general, one opportunity provided to a partial user of a bandwidth resource by the capacity information provided to him under the present invention is that of deciding whether under the particular circumstances represented by the present capacity information he wishes to go ahead with his own communication, or perhaps wait until it can take place at lower cost due to higher available capacity at a later time.

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Under the present invention, partial users with simple applications will use the above described capacity information at a link layer of overall parallel network arrangements to operate simple packet schedulers. partial users whose traffic will consists of more sophisticated multimedia applications will use the above

15   described capacity information in conjunction with algorithms to achieve their communications requirements at improved efficiency and reduced cost. To facilitate this, means can be provided to convey the profiles of the application layers both at the point of source of content providers and at end-user stations. The means can consist of Application Programming Interfaces (API) which

20   would allow applications authors to write appropriate software for increased exploitation of the capacity information. Such algorithms determine how long to queue or delay message elements before it becomes essential to send them, so allowing higher priority messages to use the bandwidth resource and also to achieve maximum utilisation of the available bandwidth.

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In addition to the above described profiles, the bandwidth provider can also transmit cost profiles to the partial users. These will provide information on how transmission cost varies. Also, yet further advantages arise from the present invention when used in conjunction with a method and apparatus for providing a

30   service in a communication system as described in the co-pending patent

application by the present inventors entitled "Providing a Service in a Communication System" GB9818585.3.

CLAIMS

1.   A method of operating within a communication system (100) wherein a

5   bandwidth provider responsible for a given bandwidth of said communication
system (100) provides different amounts of said given bandwidth to respective
partial users of said given bandwidth;
the method being characterized by comprising the steps of:
determining a bandwidth availability profile with respect to said given bandwidth;

10   determining a traffic profile with respect to traffic waiting to use said given
bandwidth; and
transmitting capacity information to a said partial user, wherein said capacity
information comprises said bandwidth availability profile and said traffic profile.

15   2.   A method according to claim 1, wherein said traffic profile is a function of a
level of said traffic waiting to use said given bandwidth.

3.   A method according to claim 1, wherein said traffic profile is a function of a
priority of said traffic waiting to use said given bandwidth.

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4.   A method according to claim 1, wherein said traffic profile is a function of a
level of said traffic waiting to use said given bandwidth and is a function of a
priority of said traffic waiting to use said given bandwidth.

25   5.   A method according to any of claims 3 and 4, wherein said function of a
priority of said traffic waiting to use said given bandwidth is calculated in a non-
linear fashion with respect to time for respective components of said traffic
waiting to use said given bandwidth.

30   6.   A method according to any claim 1 wherein said communication system is
a radio communication system.

7.   An apparatus for a communication system (100) wherein a bandwidth
provider responsible for a given bandwidth of said communication system (100)
provides different amounts of said given bandwidth to respective partial users of
5   said given bandwidth;
the apparatus being characterized by comprising:
means for determining a bandwidth availability profile with respect to said given
bandwidth;
means for determining a traffic profile with respect to traffic waiting to use said
10   given bandwidth; and
means for transmitting capacity information to a said partial user, wherein said
capacity information comprises said bandwidth availability profile and said traffic
profile.

15   8.   An apparatus according to claim 7, wherein said traffic profile is a function
of a level of said traffic waiting to use said given bandwidth.

9.   An apparatus according to claim 6, wherein said traffic profile is a function
of a priority of said traffic waiting to use said given bandwidth.
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10.   An apparatus according to claim 7, wherein said traffic profile is a function
of a level of said traffic waiting to use said given bandwidth and is a function of a
priority of said traffic waiting to use said given bandwidth.

25   11.   An apparatus according to any of claim 9   wherein said function
of a priority of said traffic waiting to use said given bandwidth is calculated in a
non-linear fashion with respect to time for respective components of said traffic
waiting to use said given bandwidth

30   12.   An apparatus according to claim 7 wherein said communication system
(100) is a radio communication system.

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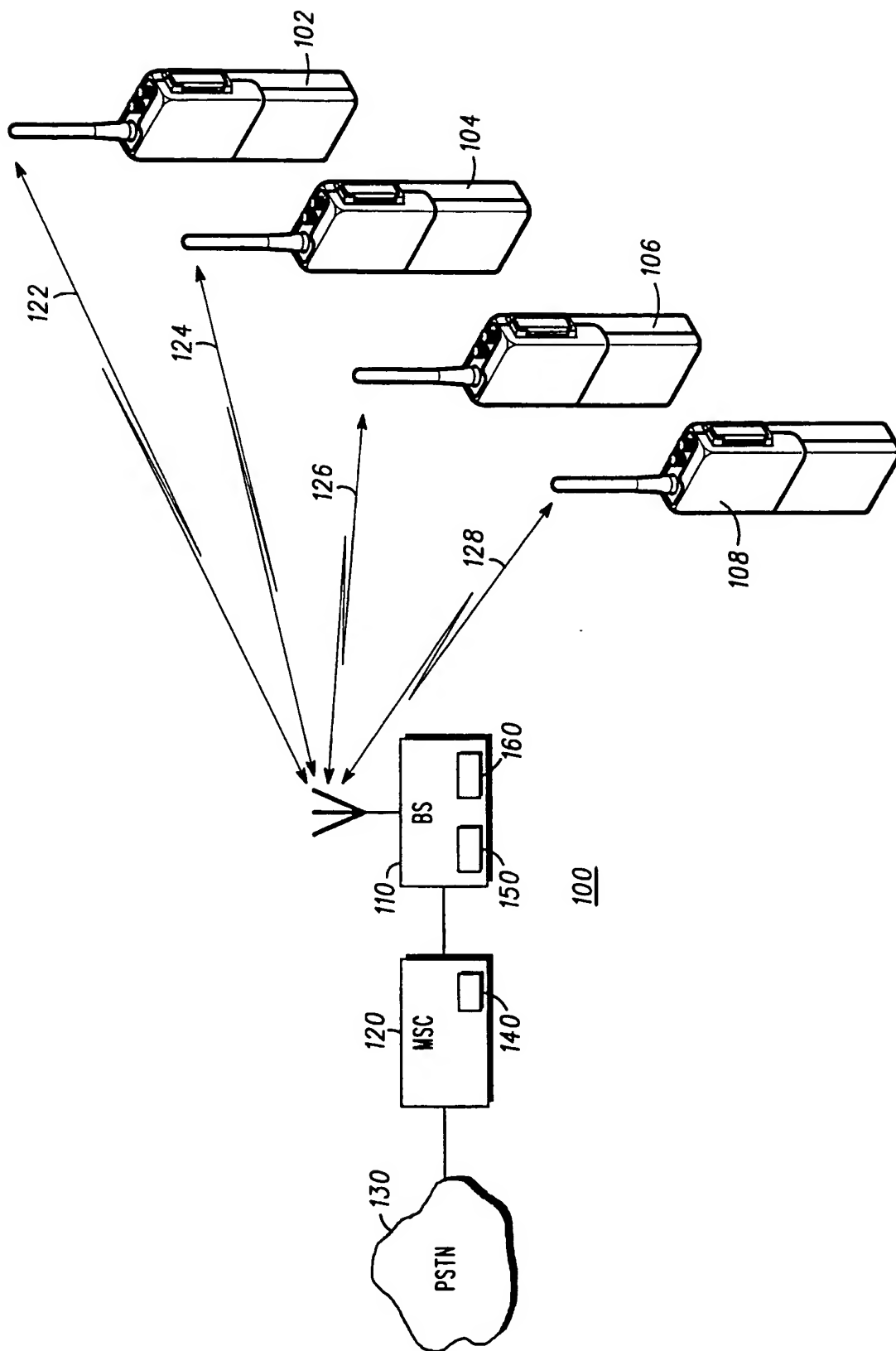
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7   H04Q   H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 4 330 857 A (ALVAREZ,III ET AL) 18 May 1982 (1982-05-18) abstract --- -/--	5,11

[X] Further documents are listed in the continuation of box C.   [X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not
    considered to be of particular relevance
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Date of the actual completion of the international search	Date of mailing of the international search report
9 December 1999	20/12/1999

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Interr   nal Application No

PCT/EP 99/05824

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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